Project No: 603502

DACCIWA

"Dynamics-aerosol-chemistry-cloud interactions in West Africa"

Deliverable

D1.2 Data Base

Due date of deliverable:	31/01/2017
Completion date of deliverable:	03/02/2017
Start date of DACCIWA project:	1st December 2013 **Project duration:** 60 months
Version:	[V0.3]
File name:	[D_1.2_Campaign_Data_DACCIWA_v1.0.pdf]
Work Package Number:	**1**
Task Number:	**2**
Responsible partner for deliverable:	**UNIVLEEDS**
Contributing partners:	**KIT, UPS, KNUST, OAU**
Project coordinator name:	Prof. Dr. Peter Knippertz
Project coordinator organisation name:	Karlsruher Institut für Technologie

The DACCIWA Project is funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 603502.

Dissemination level		
PU	Public	**x**
PP	Restricted to other programme participants (including the Commission Services)	
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CO	Confidential, only for members of the consortium (including the Commission Services)	

Nature of Deliverable		
R	Report	**x**
P	Prototype	
D	Demonstrator	
O	Other	

DOCUMENT INFO

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Changes with respect to the DoW

Issue	Comments

Dissemination and uptake

Target group addressed	Project internal / external
Scientific community	Internal and external

Document Control

Document version #	Date	Changes Made/Comments
V0.1	12/01/2017	First version distributed to members of WP1
V0.2	24.01.2017	Version for approval by the consortium
V1.0	03.02.2017	Final version

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1 Introduction

This report is the second deliverable of WP1 and aims at giving information about the data quality control of datasets acquired at the three supersites (Savè, Kumasi and Ile-Ife) during the DACCIWA ground campaign. The deliverable D1.1 concluded that the ground campaign in June and July 2016, covering a period of 7 weeks with 16 intensive operation periods, providing a unique data set with very few instrumentation failures as shown by the instrumentation status table (see deliverable D1.1). Thus, the experiment was very successful.

The September-December 2016 period was devoted to the data quality control by the operators and the upload to the DACCIWA data base. This report summarizes this work with information on the applied data quality control procedure, and the dataset available in the data base.

2 Data Quality control

2.1 The measurement sites

Intensive measurements were performed at three supersites in southern West Africa: Savè (Benin), Kumasi (Ghana), and Ile-Ife (Nigeria) from 13 June to 31 July (site locations and geographic information are given in Fig. 1 and Table 1).

The Savè site, hosted by INRAB (Institut National de Recherche Agronomique du Bénin), was jointly operated by KIT (Karlsruhe Institute of Technology) and UPS (Université Toulouse III - Paul Sabatier, Laboratoire d'Aérologie). iTUBS (Innovationsgesellschaft Technische Universität Braunschweig) operated the RPAS (Remotely Piloted Aerial System) ALADINA during the aircraft campaign.

The Kumasi site was on the estates of KNUST (Kwame Nkrumah University of Science and Technology). The site was operated by NCAS (National Centre for Atmospheric Science).

The Ile-Ife site was set at the same location as the permanent meteorological station, OAU-Met, and operated by OAU (Obafemi Awolowo University).

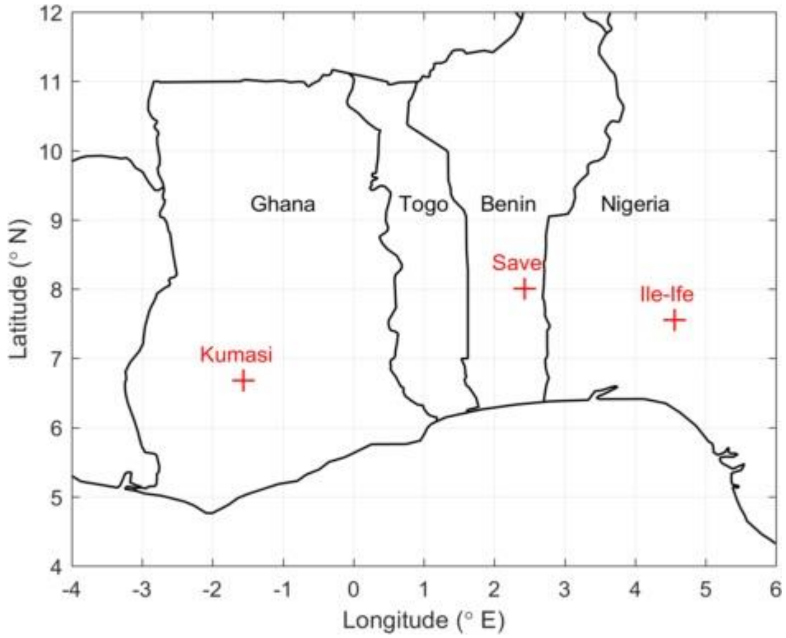

Figure 1: The locations of the supersites Kumasi, Savè and Ile-Ife in southern West Africa.

Table 1: ***Geographic location of supersites and institute in charge of the measurements***

	Savè	Kumasi	Ile-Ife
Latitude	N 8°00'03.6" (Savè site) N 8°01'04.4" (airfield)	N 6° 40' 48.56''	N 7º 33' 11.52"
Longitude	E 2°25'41.1 (Savè site) E 2°27'50.8" (airfield)	W 1° 33' 37.76''	E 4º 33' 26.70"
Operators	UPS & KIT & ITUBS	NCAS	OAU

2.2 Data quality control

A short report is given here for each site on the specific data quality control performed. Some common data quality controls or homogeneous data processing have been applied when the same instruments were deployed on the three sites.

2.2.1 Savè

UHF wind profiler: Internal automatic quality control of the Doppler spectra. Comparison of coherence between two acquisition modes. Systematic comparison of the wind speed and direction with radiosoundings.

OVLI measurements: Quality check of all soundings, comparison with concomitant balloon radiosoundings.

Normal and Frequent radiosoundings: Correction of the errors linked to the temporary shift between the launching time of the probe and that of the data acquisition system. Using all the files stored during the initial launching, this correction is applied during a virtual launching.

Surface stations: Many parameters are measured by the surface stations deployed at the Savè site. Several parameters were measured by different types of sensors or at different places. The data have been systematically compared. E.g., the TK3 software (for KIT) and Eddy-pro software (for UPS) were applied to calculate the energy balance components and flags indicate the quality of the turbulent fluxes.

Doppler lidars: Radial velocity, uncalibrated backscatter and signal-to-noise ratio are uploaded as provided by the manufacturer software.

Sodar: Internal automatic quality control and systematic comparison of wind speed and direction with radiosoundings and UHF profiler.

Microwave radiometer: During post processing offset correction of liquid water path was applied. Systematic comparison of temperature profiles with radiosoundings.

Cloud radar: Radial velocity, radar reflectivity and linear depolarization ratio are uploaded as provided by the manufacturer software.

Ceilometer: Cloud base height estimated from the manufacturer's algorithm is compared with the estimate obtained with the STRAT (Structure of the Atmosphere) algorithm.

Sun photometer: Several parameters (e.g. aerosol optical depth, Angstroem) are uploaded as available on AERONET website.

X-band radar: No quality control, data converted to netCDF files using proprietary software provided by the manufacturer.

MRR: Proprietary software, developed by Ulrich Blahak. Attenuation is taken into account, vertical velocities are neglected. Vertical velocities can introduce severe errors in MRR measurements.

Disdrometer: Raw data uploaded as provided by the manufacturer. No quality control.

Chemistry: CCC instrumentation was calibrated before and after the campaign. Data has been filtered and validated, and averages over 1min were determined, when 75% of data were available during the interval.

2.2.2 Kumasi

All systems on this site had the time of the logging systems set daily to a GPS driven time server. If the time stamp is suspect this is flagged.

Normal and Rapid radiosoundings: Each sounding is reanalyzed to correct for the surface observation errors linked to the temporal shift between the launch time and the time of entry of the surface observations by the operator.

Flux: Statistical analysis with combined quality flags adapted from Foken et al. 2012, (Chapter 4 of "Eddy Covariance: A Practical Guide to Measurement and Data Analysis", Springer). ITC determination follows Wichura and Foken 1995 and Foken and Wichura 1996. Note this analysis uses stability range from EDDYCALC to extend Foken's range. Stationarity determination follows Foken and Wichura 1996 while Skewness and Kurtosis determinations follow Vickers and Mahrt 1997. It is for the end user to make informed decisions on the information provided as to how the supplied components are used. Raw data is provided and split into 30 minute runs. Sensor flagged if broken or derived parameters out of range.

Sodar: Comparison of wind speed and direction with radiosoundings, signal consensus assessment and background noise level assessment. Sensor flagged if broken or derived parameters out of range.

Microwave radiometer: Receiver bank stability analysis, temperature comparison with sondes. Sensor flagged if broken or derived parameters out of range. Rain events flagged.

Ceilometer: Backscatter determined with the manufacturer algorithm. Noise flagged. Sensor flagged if broken or out of range.

Sun photometer: Being performed by ARM facility. No details available.

MRR: Attenuation is taken into account. Reflectivity used to flag noise in data. Sensor flagged if broken or derived parameters out of range.

Sonic: 1 minute averages uploaded. Means and deviations have stated acceptable ranges. Sensor flagged if broken or out of range.

Licor: 1 minute averages uploaded. Means and deviations have stated acceptable ranges. Sensor flagged if broken or out of range.

Energy Balance 1&2: Consistency between sensors, soil moisture >80kPA can cause loss of contact between soil and sensor (this is flagged). Each sensor flagged if broken or out of range.

Imagery: Camera took 1s images throughout the deployment period. These have been animated into daily movies.

AWS: Each sensor flagged if broken or out of range. T, RH, PP compared with radiometer and sondes, rain rate compared with MRR.

2.2.3 Ile Ife

Surface meteorological parameters: Different electronic sensors (slow and fast response systems) were mounted at the station for in-situ measurements of the key meteorological variables. The data collection was done routinely by using direct cable connections to the dataloggers. Concerted efforts were made to ensure that the equipment was in calibration and worked with minimal downtimes. Further all the parameter values were checked for trends and to eliminate the spurious data.

Sodar: METEK PCS.20000 (24 – antennae sodar) was operated continuously throughout the study period. Ten (10) minutes averages of the horizontal wind speed components and wind direction from 30 m up to 510 m were archived after performing plausibility tests using software provided by the manufacturer. Further, the graphical displays of the times series (time-height sections) were plotted and compared to the COSMOS model analysis.

Energy Balance: A complete Campbell Scientific open-path eddy covariance system (OPEC) was operated at 10 Hz with a proprietary software for both the data acquisition and reduction. Measurements of surface convective heat fluxes (sensible and latent), were determined with the Campbell software and compared with the TK2 by the University of Bayreuth in Germany.

Surface Layer Profiling: Profiling of wind speed, air temperature and relative humidity at 5 levels (log-linear spaced) on a 15 –m mast was recorded using high-sensitivity cup anemometers and air temperature/relative humidity probes. The data was stored as 1 min. averages and checked for consistency and spurious values using standardized QA/QC protocols.

Radiation Balance: Using a 4-component net radiometer, NR01, incoming/outgoing shortwave (solar) and longwave (atmospheric) radiation were sampled at 10 secs intervals and recorded as 1 minute averages. The data were subject to standardized QA/QC procedures and uploaded to the database.

Tethered radiosonding: A tethered radiosonde system (GRAW Instrument) with ancillary instruments (antenna and receiver) and GPS tracker was used to carry out probing of air temperature, wet bulb temperature and pressure in the lowest 1000 m of the boundary layer. Some soundings in the month of June were not taken due to lack of helium gas.

Aerosol Optical Depth: A hand-held sun photometer (Calitoo) was manually operated to measure the aerosol optical depth (AOD) at or about the local zenith, that is, between the 11.30 and 12.30 UTC. However on days with a heavy cloud cover (stratocumulus or cumulus congestus) which totally obscure the solar disc (no direct beam), AOD measurements could not be taken.

Cloud Base Temperature: A hand-held infrared radiometer was used to measure cloud base temperature (CBT) at the same time the radiosounding (from tethered radionsonde) was carried out. To correlate the manual measurements, the values were compared to the downwelling longwave radiation obtained separately from the 4-component net radiometer from which the CBT was deduced.

Rainfall Amount: A tipping bucket rainguage (type TE 525) was used to record rainfall amount at the OAU site. The tip per bucket is 0.254 mm. The datalogger was programmed to record the rainfall amount as a totalization of the number of tips that occurred within a specified period.

2.2.4 Common data quality control and processing

Surface turbulent fluxes processing: A surface station for energy balance was deployed at each site. Each operator has its own software to process the surface fluxes by eddy-covariance method.

To determine the impact of the software on the flux calculations, KIT will apply the TK3 software to a few-day dataset from each supersite.

Ceilometer: For uniform determination of cloud base from ceilometer backscatter data the same algorithm will be applied to data from Kumasi and Savè. For the Savè site cloud base height estimated from the manufacturer's algorithm is compared with the estimate obtained with the STRAT (Structure of the Atmosphere) algorithm. STRAT algorithm retrieves vertical distribution of cloud and aerosol layers in the boundary layer as well as in the free troposphere. The performance of both algorithms is evaluated using statistical analysis methods.

3 DACCIWA Data Base: BAOBAB

3.1 BAOBAB

The BAOBAB (Base Afrique de l'Ouest Beyond Amma Base) data base hosts projects on West Africa: AMMA, Fennec, Impetus and DACCIWA.

The link for DACCIWA is :http://baobab.sedoo.fr/DACCIWA/

Several criteria can be used to search for DACCIWA dataset acquired during the ground campaign: By country, by instrument, by parameters, by platform type, and by project. Each data set is associated to a metadata file which gives detailed information of the measurement site (location, altitude, ..), the parameters (sensors, accuracy, …).

3.2 Datasets in BAOAB

For each of the three sites, one figure presents a screen shot of the BAOBAB data base with the directory names of the datasets acquired at that site. In addition, several tables precise the instrumentation used to acquire the dataset, the directory names over which the dataset is reachable in the BOABAB data base and the physical parameters available in each dataset. The data set availability is indicated by a sign ( : dataset available). In case the dataset is not available yet, some comments indicate the reasons why and when the dataset will be uploaded.

3.2.1 Savè

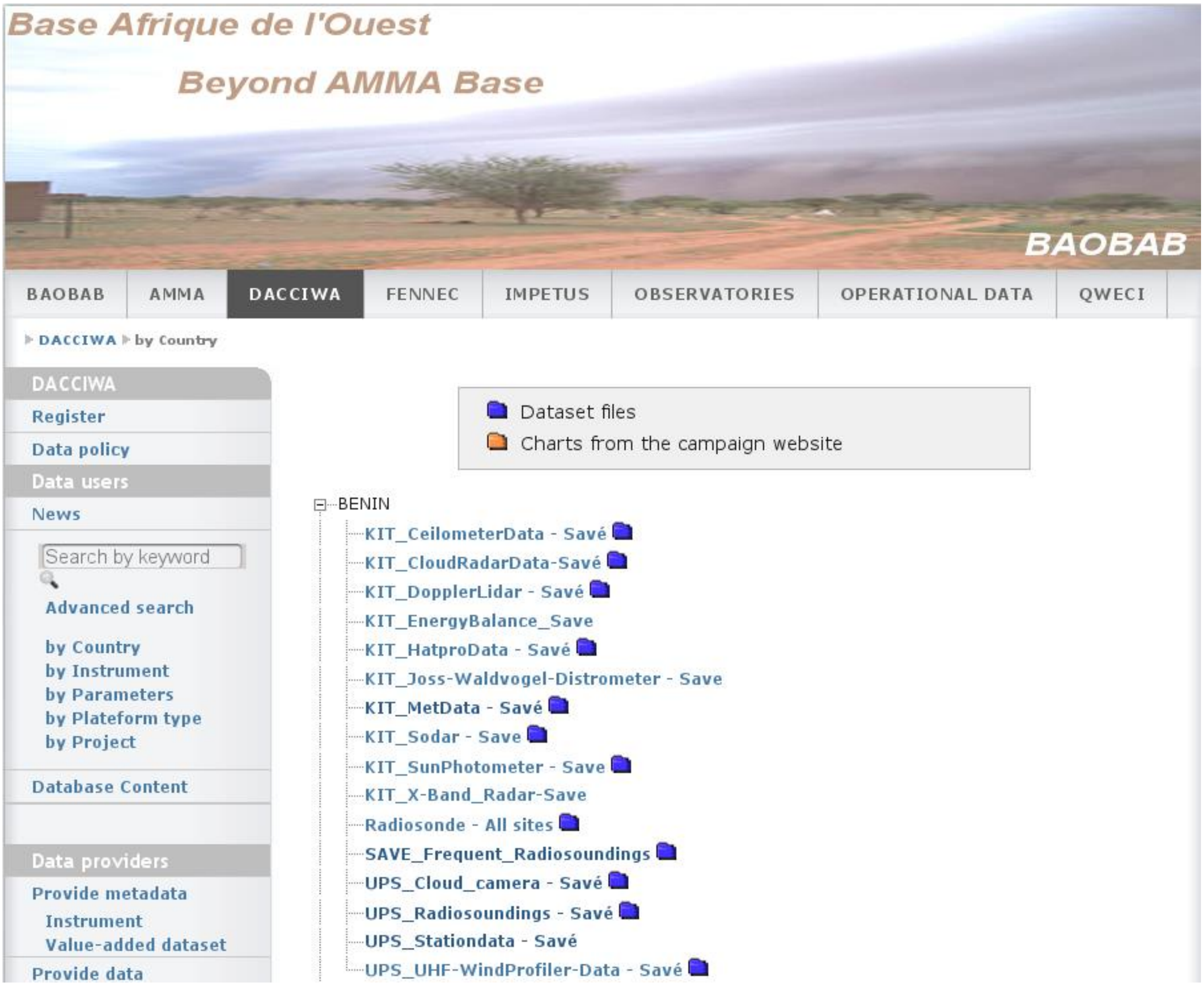

Figure 2: Screen shot of the BAOBAB data base for Savè site. The page is reached using the "by country" criteria (in the left panel).

Table 2: ***Surface measurements.***

Instrument	Operator	Directory name in the BAOBAB Data Base	Parameters	Dataset available
Energy balance station	KIT	KIT_EnergyBalance_Savè	Q, H, E, B, SW, LW, SM, ST, T, wind	✓
		KIT_MetData-Savè (*)	SW, LW, SM, ST, T, RH, P, wind, RF	✓
Energy balance station and chemistry tower	UPS	UPS_EnergyFlux_30min_Savè	H, E, Tau, U*, L, wind	✓
		UPS_MetData-radiation_1min_Savè	Q, SW, LW, SM, ST, T, RH, P, prec, B	✓

Q: Net radiation, H: Sensible heat flux, E: Latent heat flux, B: Soil heat flux, Tau, momentum flux, SW: Short-wave radiation components, LW: Long-wave radiation components, SM: Soil moisture, ST: Soil temperature, T: Air temperature, RH: Relative Humidity, P: Pressure, prec: Precipitation, U*: friction velocity, L: Obukhov length scale.

(*)10min averages are uploaded ; 1-min averaged files still need to be linked

Table 3: ***Measurements in the boundary layer and above***

Instrument	Operator	Directory name in the BAOBAB Data Base	Parameters	Dataset available
Sodar	KIT	KIT_Sodar-Savè	Horizontal wind profile (0-600 m)	✓
UHF wind profiler	UPS	UPS_UHF-windprofiler-Data-Savè	Horizontal wind profiles, reflectivity (200 - 4000 m)	✓
Wind lidars	KIT	KIT_DopplerLidar - Savè	Lidar 1: Radial velocity profiles, scanning or vertical stare (400-10 000 m AGL) Lidar 2: Vertical velocity profiles (40-600 m AGL)	✓ ✓
Microwave radiometer	KIT	KIT_HatproData-Savè	Temperature and humidity profiles, IWV, LWP, CBT	✓
Radiosondes (normal RS and frequent RS)	UPS	UPS_Radiosoundings-Savè SAVE_Frequent_Radiosoundings	T, RH, P, Td, altitude, wind profiles, latitude, longitude	✓ ✓

IWV: Integrated water vapour, LWP: Liquid water path, CBT: Cloud base temperature

Table 4: ***Measurements of cloud characteristics and precipitation***

Instrument	Operator	Directory name in the BAOBAB Data Base	Measured parameters	Dataset available
Cloud radar	KIT	KIT_CloudRadarData-Savè	Radial velocity, cloud top	✓
Ceilometer	KIT	KIT_CeilometerData-Savè	Cloud base	✓
X-Band radar	KIT	KIT_X-Band_Radar-Savè	Precipitation	✓
MRR, distrometers	KIT	KIT_MRR – Savè, KIT_Distrometer - Savè	Precipitation, drop size distribution	✓
Cloud camera	UPS	UPS_Cloud-Camera-Savè	IR & visible images	✓

Table 5: Aerosol measurements

Instrument	Operator	Directory name in the BAOBAB Data Base	Parameters	Dataset available
Grimm aerosol spectrometer	KIT	This instrument failed after a few days of the campaign and could not be repaired in time.		
Sun photometer	KIT & University Reading	KIT_SunPhotometer - Savè	Aerosol optical depth (normal mode and cloud mode)	✓

Table 6: Chemistry measurements

Instrument	Operator	Directory name in the BAOBAB Data Base	Parameters	Dataset available
49i Thermo environment	UPS	UPS_Chemical_Compounds_Conposition-Savè	O3 concentration	✓
42CTL Thermo environment	UPS	UPS_Chemical_Compounds_Conposition-Savè (**)	NO, NO2 concentratrion	
CO Environnement SA	UPS	UPS_Chemical_Compounds_Conposition-Savè (**)	CO concentration	✓
Fast Isoprene Sensor HILLS Scientific	UPS	UPS_Chemical_Compounds_Conposition-Savè (**) UPS_Turbulent_Biogenic Fluxes (**)	Isoprene concentration Tower isoprene fluxes	
17i Thermo environment	UPS	UPS_Soil_Biogenic_Fluxes (**)	NO, NH3 fluxes	

(**) Data uploaded in the data base by mid-March

(**) Turbulent biogenic flux of NO and NO2 turbulent fluxes will not be available because of a break of the flux instrumentation at the beginning of the campaign

*(**) **Chemical Compound Concentration** of NO, NO2 will be delayed by 1 month to allow intercalibration of the instrumentation with aircraft instrumentation*

*(**) **Soil biogenic fluxes** of NO, NH3 by chamber technique will be delayed by 1 month to allow intercalibration of the instrumentation with aircraft instrumentation*

*(**) **Chemical Compound Concentration** of isoprene will be delayed by 2 month because of difficulties in data treatment*

(**) Turbulent biogenic flux of isoprene turbulent fluxes will be delayed by 2 months because of difficulties in data treatment CCC of isoprene

Table 7: RPASs (remotely piloted aerial vehicles)

Instrument	Operator	Directory name in the BAOBAB Data Base	Parameters	Dataset available
RPAS Aladina	iTUBS	ITUBS_ALADINA-RPAS - Savè	Flight segments including vertical profiles (up to CB / maximal 1000 m AGL) and horizontal profiles (1 km length) of temperature, humidity (both under total pressure conditions), Wind, Position (in WGS-84 coordinates). Upwelling and downwelling irradiance (w/o absolute calibration), RPAS Attitude,Timestamps in GPS-Dayseconds, measurement rate 100 Hz	✓
RPAS OVLI	UPS	UPS_OVLI-RPAS – Savè	Vertical profiles of temperature, humidity, potential temperature, horizontal wind form surface. Maximum height reached: 200 m to 1000 m.	✓

3.2.2 Kumasi

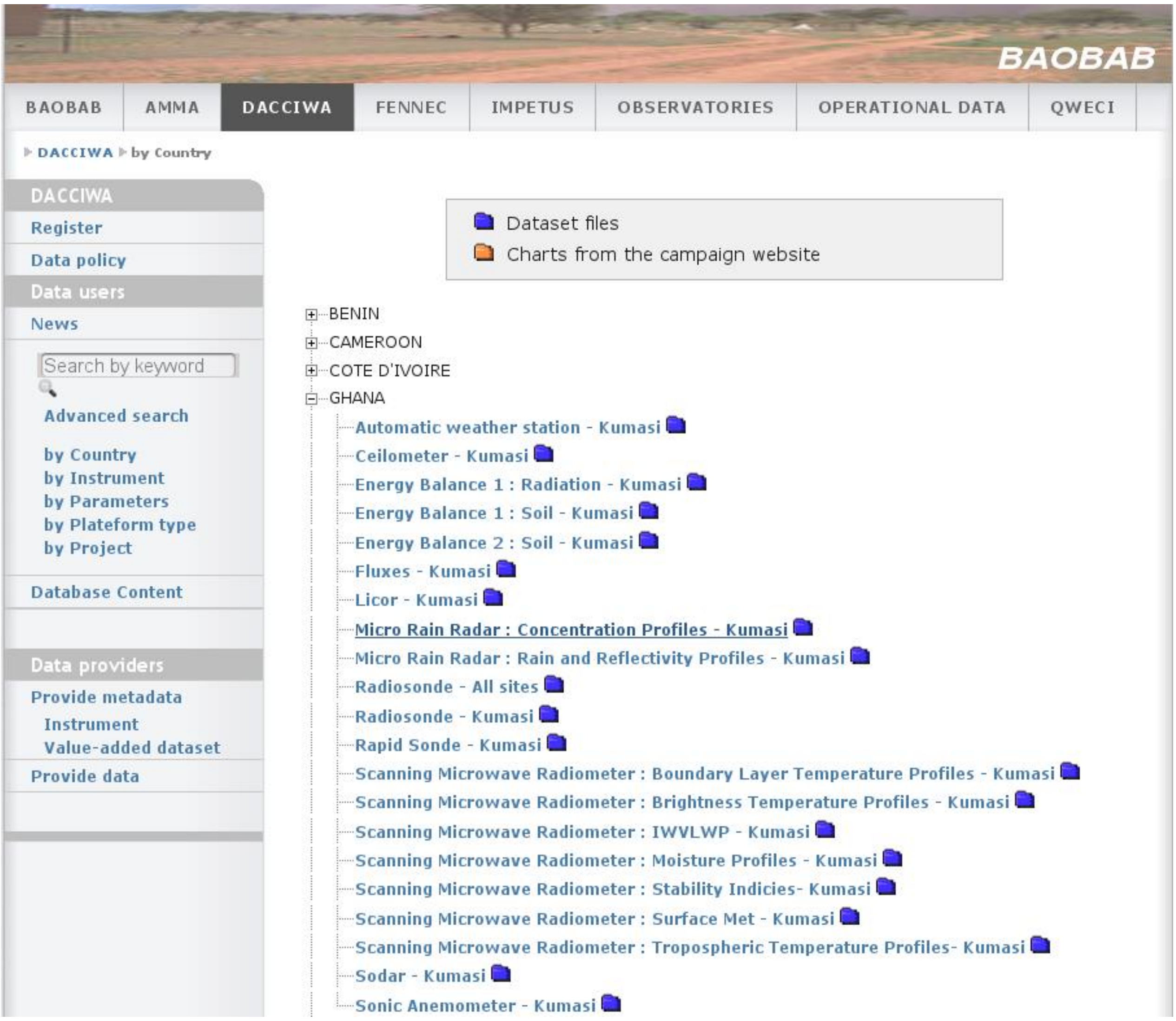

Figure 3: Screen shot of the BAOBAB data base for the Kumasi site. The page is reached using the "by country" criteria (in the left panel).

Table 8: Surface measurements

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Energy balance station	NCAS	Energy Balance 1 : Radiation – Kumasi	SWup, LWup, SWdown, LWdown	✓
		Energy Balance 1 : Soil - Kumasi	SM, ST, SHF	✓
		Energy Balance 2 : Soil - Kumasi	SM, ST, SHF	✓
Flux station	NCAS	Fluxes - Kumasi	Flux components	✓
		Licor - Kumasi	H20, CO2, T, PP, DPT	✓
		Sonic Anemometer - Kumasi	WS, WD, U, V, W, Tson	✓
AWS	NCAS	Automatic weather station - Kumasi	T, RH, PP, WS, WD, PPT	✓

Q: 1Hz Net radiation, H: 1Hz Sensible heat flux, E: 1Hz Latent heat flux, B: 1Hz Soil heat flux, SW: 1Hz Short-wave radiation components, LW: 1Hz Long-wave radiation components, SM: 1Hz Soil moisture, ST: 1Hz Soil temperature, T: 5 min Air temperature, PP: 5 min pressure, WS: 5 min horizontal wind, WD: 5 min horizontal wind direction, PPT: 5 min precipitation, RH: 5 min Relative Humidity, P: 20Hz Pressure, H20: 20Hz water vapour concentration, CO2: 20Hz carbon dioxide concentration, U,V,W: 20Hz wind speed components, TS: 20Hz sonic temperature, TL: 20Hz licor air temperature, DT: 20Hz licor dew point temperature

Table 9: Measurements in the boundary layer and above

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Sodar	NCAS	Sodar - Kumasi	Horizontal wind profile (0-1000 m), Acoustic signal strength, U, V, W, sigma U, sigma V, sigma W	✓
Microwave radiometer	NCAS	Scanning Microwave Radiometer : Boundary Layer Temperature Profiles - Kumasi	Temperature profiles	✓
		Scanning Microwave Radiometer : Brightness Temperature Profiles - Kumasi	Brightness temperature profiles	✓
		Scanning Microwave Radiometer : IWVLWP - Kumasi	IWV, LWP	✓
		Scanning Microwave Radiometer : Moisture Profiles - Kumasi	Humidity profiles	✓
		Scanning Microwave Radiometer : Stability Indices- Kumasi	Stability Indices	✓
		Scanning Microwave Radiometer : Surface Met - Kumasi	T, RH PP	✓
		Scanning Microwave Radiometer : Tropospheric Temperature Profiles- Kumasi	Temperature Profile	✓
Radiosondes (normal and frequent)	NCAS	Radiosonde - Kumasi	T, RH, PP, WS, WD, Z, lat, long	✓
		Rapid Sonde - Kumasi	T, RH, PP, WS, WD, Z, lat, long	✓

IWV: Integrated water vapour, LWP: Liquid water path, CBT: Cloud base temperature

Table 10: Measurements of cloud characteristics and precipitation

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Ceilometer	NCAS	Ceilometer - Kumasi	Attenuated aerosol backscatter coefficient	✓
MRR	NCAS	Micro Rain Radar : Concentration Profiles - Kumasi	Precipitation Rate, LWC, Reflectivity	✓
		Micro Rain Radar : Rain and Reflectivity Profiles - Kumasi	Drop size distribution, spectral radar returns,	✓
Camera	NCAS	Camera - Kumasi	Site imagery	

Table 11: Aerosol measurements

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Sun photometer	NCAS	Sun Photometer - Kumasi	Optical depth	

3.2.3 Ile-Ife

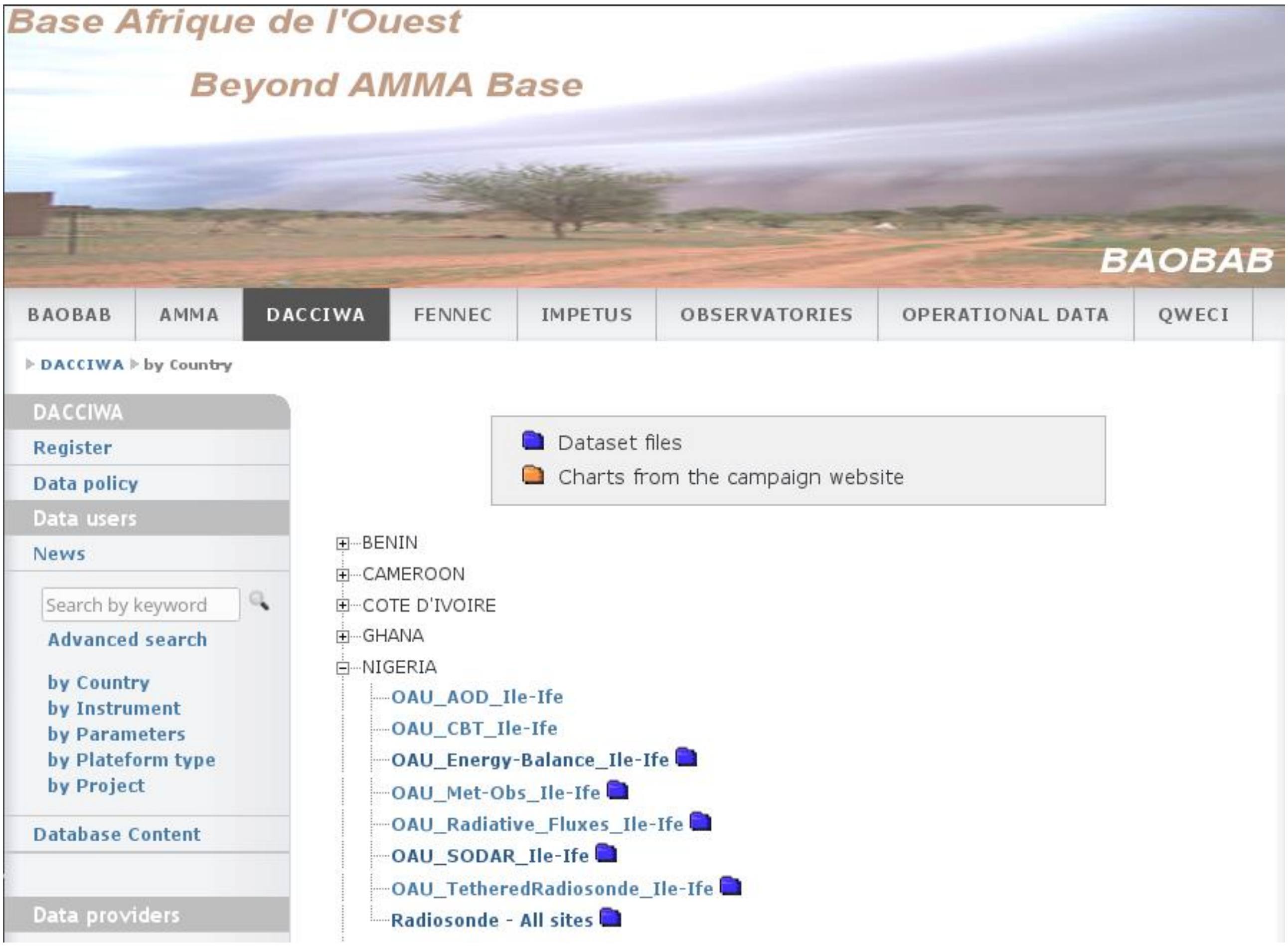

***Figure 4: Screen shot of the BAOBAB data base for Ile-Ife site. The page is reached using the "by country"* criteria (in the left panel).**

Table 12: Surface measurements

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Energy balance station	OAU	OAU_Energy-Balance_Ile-Ife	H, E, B, SM, ST, T, P, wind Q, SW, LW	✓
Radiative Fluxes	OAU	OAU_Radiative_Fluxes_Ile-Ife	Q, SW, LW	✓
Surface Station	OAU	OAU_Met-Obs_Ile-Ife	T, RH, P, wind, prec.	✓

Q: Net radiation, H: Sensible heat flux, E: Latent heat flux, B: Soil heat flux, SW: Short-wave radiation components, LW: Long-wave radiation components, SM: Soil moisture, ST: Soil temperature, T: Air temperature, RH: Relative Humidity, P: Pressure, prec: Precipitation

(**) To be uploaded by the end of February 2017.

Table 13: Measurements in the boundary layer and above

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Sodar	OAU	OAU_SODAR_Ile-Ife	Horizontal wind profile (0-600 m)	✓
Tethered radiosonde	OAU	OAU_TetheredRadiosonde_Ile-Ife	T, RH profiles	✓

Table 14: Measurements of cloud characteristics and precipitation

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Handhold infrared radiometer	OAU	OAU_Cloud_Ile-Ife	Cloud base temperature	
Rain gauge	OAU	OAU_Cloud_Ile-Ife	precipitation	

Table 15: Aerosol measurements

Instrument	Operator	Directory name in the BAOBAB Data Base	Meteorological parameters	Dataset available
Sun photometer	OAU	OAU_AOD_Ile-Ife	Aerosol optical depth	

4 Conclusion

The measurement campaign conducted in summer 2016 in West Africa provided a unique data set. In total, 15 IOPs were performed with low-level clouds occurring nearly every night at all three supersites. Additionally, the environmental conditions were captured which will allow investigating the dependence of the evolution of nocturnal clouds on controlling factors.

After the campaign, the data from the different measurement systems were quality controlled and uploaded to the DACCIWA database. The same algorithms were applied for calculations of parameters when possible in order to investigate the impact of different algorithms on the data. The quality-controlled data are available now for the whole DACCIWA community as well will be used by WP1 members for cross checking as well as for the studies outlined in the WP1 objectives.